Activity 1 - Monohybrid Cross

In corn plants, seed traits for color and texture demonstrate Mendel's postulates. The trait studied in this activity is seed color. Seed color is controlled by a gene that has two alleles. The dominant allele causes the production of purple pigment in the seed coat. The recessive allele results in the production of no pigment causing the seed coat to appear white. There are three possible genotypes and two possible phenotypes for this trait. Fill in the key for seed color.

KEY:

Alleles _____ = purple pigment dominant allele

_____ = no pigment recessive allele

Genotypes _____

Phenotypes _____

This activity demonstrates the segregation of alleles through a cross between parents that are both heterozygous for the seed color trait.

Fill in the standard outline for the cross. Circle the gametes.

CROSS OUTLINE:

Cross	**Male**	**x**	**Female**
Phenotype	_____	**x**	_____
Genotype	_____	**x**	_____
Gametes	_____	**x**	_____

Draw the Punnett box for this cross. Determine the size of the Punnett square from the gametes. Record the percentages of each phenotype.

PUNNETT SQUARE:

PHENOTYPE RESULTS:

_____

_____

Determine the number of kernels of each phenotype on specimen A as described in the "Counting the kernels" section. Record the number of kernels of each phenotype in Data Table 1.

Counting the Kernels

1. Place a rubber band around a specimen so that it bisects the ear lengthwise. See Figure 1. The rubber band divides the ear into sides and makes counting the kernels easier.
2. Count the kernels that have the same phenotype on one half of the ear. The easiest way to do this is to hold the ear so that the rubber band is horizontal and begin counting from left to right, row by row, beginning with the row adjacent to the rubber band.
3. Record the number of kernels in the side 1 column of the data table.
4. Count the kernels with that phenotype on the other side and record the number in the side 2 column.
5. Repeat this process with another phenotype.
6. Add side 1 and side 2 for each phenotype and record the sum in the total column.
7. Calculate the percentage of each phenotype by dividing the number of kernels for a phenotype on an ear by the total number of kernels on the ear.

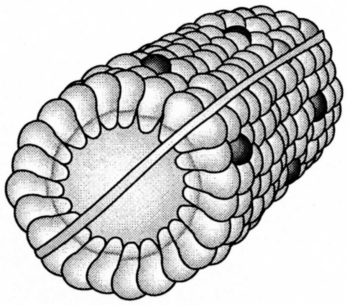

Figure 1

DATA TABLE 1

Phenotype	Side 1	Side 2	Total	Percentage
Purple				
White				
				100%

QUESTIONS

1. What is a dominant allele? A recessive allele?

2. For each phenotype, compare the predicted percentages with the observed percentages in the data table. Are the results exactly the same? _____ (If the answer is "yes" then skip to question #4.

3. Are the observed results close to the predicted results? _____

4. Why would you expect a discrepancy between predicted and observed results.

5. How does this cross illustrate the Law of Segregation?

Part 2 - Monohybrid Testcross

When a single purple kernel of corn is observed, the following can be assumed to be true:

- Each cell in the kernel has two genes controlling seed-coat color (see Mendel's first postulate).
- Each cell has at least one, but maybe two, alleles for purple pigment. Since the kernel is purple, there must be at least one copy of instructions for making purple pigment.

To determine whether the genotype of the purple seed is homozygous dominant (PP) or heterozygous (Pp) a testcross must be performed. A testcross is the process of mating the organism of unknown genotype with an organism that is homozygous recessive for the trait in question (white seed coat).

In a testcross, the purple seed of unknown genotype and a kernel with a homozygous recessive genotype are planted and grown into mature corn plants. Mature plants have tassels (male structures, which produce pollen) and immature cobs (female structures that contain eggs). Pollen from the tassels of the purple seed plant is dusted onto the silk on the ear of the white seed plant and pollen from the tassels of the white seed plant is dusted onto the silk of the purple seed plant. The tassels and cobs must be kept covered before and after pollination to ensure that self-pollination does not occur. As the cobs mature, seed color becomes apparent.

There are two possible outcomes.

If the purple seed was homozygous, what would the results be? Set up the cross outline and make the appropriate Punnett box. List the resulting phenotypes.

CROSS OUTLINE:

Cross	Male	x	Female
Phenotype	_____	x	_____
Genotype	_____	x	_____
Gametes	_____	x	_____

PUNNETT SQUARE:

PHENOTYPE RESULTS:

_____

_____

If the purple seed was heterozygous, what would the results be? Set up the cross outline and make the appropriate Punnett box. List the resulting phenotypes.

CROSS OUTLINE:

Cross	Male	x	Female
Phenotype	_____	x	_____
Genotype	_____	x	_____
Gametes	_____	x	_____

PUNNETT SQUARE:

PHENOTYPE RESULTS:

_____

_____

Activity 2

The testcross of the purple kernel has been done for you and the offspring (the kernels on the ear) are ready for you to count. Determine the number and percentage of kernels of each phenotype on specimen B as described in the "Counting the Kernels" section on page S6. Record the information in Data Table 2.

DATA TABLE 2

Phenotype	Side 1	Side 2	Total	Percentage
Purple				
White				
				100%

QUESTIONS

1. What was the genotype of the original purple kernel?

2. What evidence can you show to support your conclusion?

3. How could this process be useful in a real life situation?

Activity 3 The Dihybrid Cross

Corn specimen C is the result of a cross between two plants that are heterozygous for both seed coat color and seed texture. Seed color was studied in Activities 1 & 2. You may want to look back at those activities to remind yourself of the genes involved in the control of purple and white seed coats.

Seed texture is the result of the way starch is stored within the seed. If the corn has at least one copy of the dominant allele for the seed texture gene, it produces an enzyme that causes sucrose to be converted to starch, which is more loosely packed than sucrose, causing a smooth seed. The presence of two recessive alleles results in less sucrose being converted. As the corn is dried, the seed coat collapses because there is less starch, giving the seed a wrinkled appearance.

Make a key for the seed texture gene. Refer to the key for seed color in on page S5.

KEY (Seed texture):

Alleles _____ = smooth seed texture dominant allele

_____ = wrinkled seed texture recessive allele

Genotypes _____

Phenotypes _____

Complete the cross outline for a cross between parents that are heterozygous for both traits. Circle the gametes.

CROSS OUTLINE:

Cross	**Male**	**x**	**Female**
Phenotype	_____	x	_____
Genotype	_____	x	_____
Gametes	_____	x	_____

Draw and complete a Punnett square for the cross. Determine percentage of phenotypes.

PUNNETT SQUARE:

PHENOTYPE RESULTS:

Determine the number of kernels of each phenotype combination on specimen C as described in the "Counting the Kernels" section on page S5. Record the numbers and percentages in Data Table 3.

DATA TABLE 3

Phenotype	Side 1	Side 2	Total	Percentage
purple:smooth				
purple:wrinkled				
white:smooth				
white:wrinkled				
				100%

QUESTIONS

1. In your own words, explain independent assortment.

2. What would the results have been if the genes for seed coat color and seed texture were located on the same chromosome?

Activity 4 Dihybrid Testcross

Look at the specimen that you used in Activity 3. Find one kernel that is purple and smooth.

What are all of the possible genotype combinations that this kernel could have?_____

_____

As mentioned in Part 2 of this lab, a testcross can be used to determine unknown genotypes. Corn specimen D is the result of a testcross between a plant of unknown genotype and an individual that is homozygous recessive for both traits.

Determine the number of kernels of each phenotype on specimen D as described in the "Counting the kernels" section on page S5. Record the numbers and percentages in Data Table 4.

DATA TABLE 4

Phenotype	Side 1	Side 2	Total	Percentage
purple:smooth				
purple:wrinkled				
white:smooth				
white:wrinkled				
				100%

Using knowledge and skills you have obtained from activities 1 through 3, examine the possible crosses and determine the parent with the unknown genotype. Use the area below to list the possible crosses and for any subsequent work that would help you determine which cross produced specimen D.

WORK SPACE

Draw the cross that would predict the results that you observed. Complete the cross outline and draw the appropriate Punnett square.

CROSS OUTLINE:			
Cross	**Male**	**x**	**Female**
Phenotype	_____	**x**	_____
Genotype	_____	**x**	_____
Gametes	_____	**x**	_____

PUNNETT SQUARE:

QUESTIONS

1. Based on these results what was the genotype of the purple, smooth parent? _____

2. Which one of Mendel's postulates supports your conclusion? _____ Explain

3. How does this activity illustrate independent assortment?